High Strength Weight Reduction Materials

Attachment Techniques for Heavy Truck Composite Chassis Members

Background

In terms of materials performance requirements, heavy vehicle chassis have components which are excellent candidates to potentially be replaced with low-density structural composite materials.

At the start of FY 2005, researchers at the Oak Ridge National Laboratory (ORNL) and the Pacific Northwest National Laboratory (PNNL) had already begun a research effort focused on developing joining techniques to overcome the technical issues associated with joining lightweight materials in heavy vehicles. The work is being performed concurrently with an industry program led by the National Composites Center to develop and commercialize composite chassis components, which will require resolution of the joining challenges. Different modeling techniques are being evaluated to assist in the performance prediction of potential joint designs.

Technology

Researchers at ORNL have been working closely with AlphaSTAR to build on the capabilities of its commercial software, GENOA, a progressive failure analysis tool developed specifically for fiber-reinforced composite materials. ORNL has worked with AlphaSTAR to develop and validate an interface between GENOA and the ABAQUS solver, which allows for contact modeling. This is critical for investigating damage in the composite at a bolted joint.

The resulting capability has been used to successfully evaluate the load distribution and damage in the composite due to bolt torque and subsequent loading of the bolted joint. Experimental testing validated the analytical results.

Commercialization

GENOA is commercially available software that has been used extensively in the aerospace industry to predict the strength,

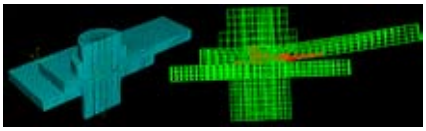

Figure 1. *GENOA model of bolted composite/steel joint with steel insert bonded to composite showing areas with damage.*

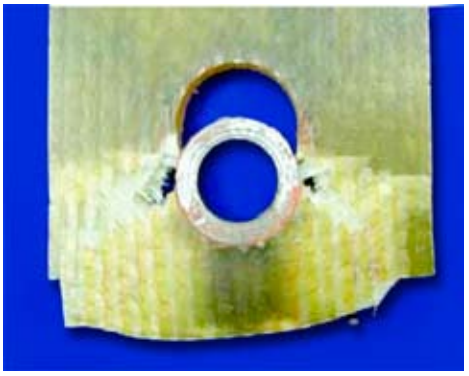

Figure 2. *Typical failure for a composite/steel lap shear specimen with a steel insert.*

Benefits

- The new software allows for more efficient design optimization of structural composite joints.
- The software will minimize required mechanical testing.

life and durability of composite components. This project is the software's first application to commercial vehicle design, specifically composite-to-metal structural joints. GENOA takes a full scale finite element model and breaks the material properties down to the microscopic level. The constituent properties are updated after each analysis iteration to reflect changes caused by damage or crack propagation.

ORNL and PNNL are working with AlphaSTAR to incorporate additional capabilities into GENOA software for optimization of bolted composite/steel joints for thick composite materials in a heavy vehicle chassis environment. The researchers are enhancing the software to make it more useful for the design of trucks and automobiles. The enhancements are being incorporated into new release versions of GENOA.

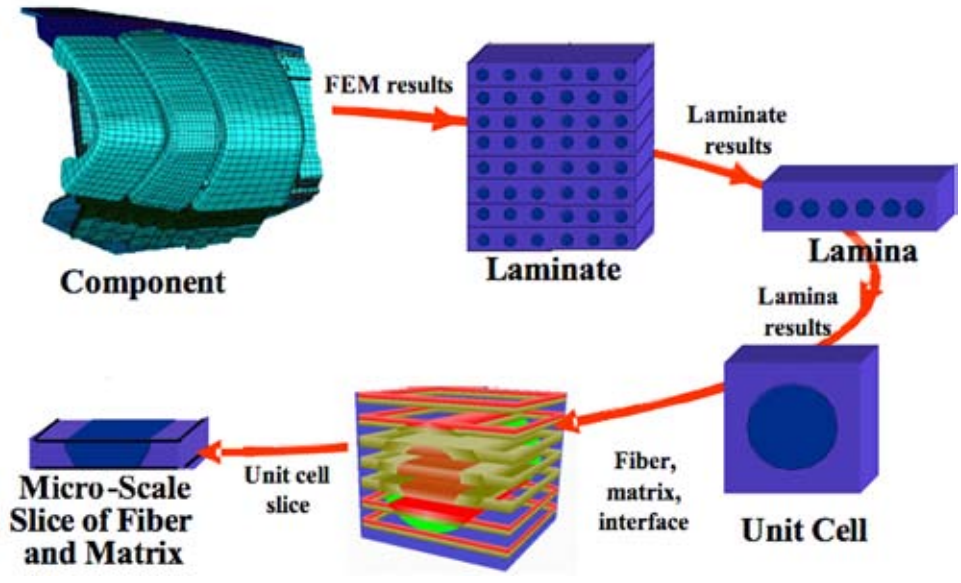

Figure 3. *Schematic of GENOA analytical hierarchy.*

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